

CLAIMS

What is claimed is:

1. A method comprising:
sending a first datum of a first parameter in uncompressed form from a downhole unit within a drill string to a surface unit; and
sending a second datum of the first parameter in compressed form from the downhole unit within the drill string to the surface unit.
2. The method as defined in claim 1 wherein sending the second datum in compressed form further comprises:
sending a first delta value being a difference between the first and second datum; and
reconstructing the second datum from the first datum and the first delta value.
3. The method as defined in claim 2 further comprising:
sending a second delta value, being a difference between the second datum and a third datum of the first parameter; and
reconstructing the third datum from the first datum, the first delta value and the second delta value.
4. The method as defined in claim 2 further comprising:
sending a second delta value, being a difference between the first datum and a third datum of the first parameter; and
reconstructing the third datum from the first datum and the second delta value.
5. The method as defined in claim 2 wherein sending the first delta value further comprises encoding a most likely value of the first delta value as a zero.
6. The method as defined in claim 5 further comprising encoding a second most likely first delta value as one of a value of one and a value of two.
7. The method as defined in claim 2 further comprising, prior to calculating the first delta value, smoothing raw data of the first parameter.

8. The method as defined in claim 7 wherein smoothing further comprises smoothing by application of substantially the following equation:

$$y_i = \frac{x_i + (\alpha * y_{i-1})}{1 + \alpha}$$

where y_i is a smoothed datum having index i , x_i is a raw datum of index i , y_{i-1} is a smoothed datum of index $i-1$, and α is a smoothing coefficient.

9. The method as defined in claim 2 further comprising selecting a number of bits to use to encode the first delta value based on the size of the first delta value.

10. The method as defined in claim 1 wherein sending the second datum further comprises sending a plurality of compressed data of the second parameter, each of the plurality of compressed data related to the uncompressed datum.

11. The method as defined in claim 10 wherein a number of compressed data is selected, at least in part, on a bit error rate of communications from the downhole unit in the drill string.

12. The method as defined in claim 1 further comprising sending a plurality of datums of the first parameter in compressed form, a number of datums sent determined as a function of an error rate in data transmission.

13. A drill string assembly comprising:

a downhole tool designed to generate a first datum and a second datum being one of drilling parameters, borehole parameters and formation properties;

a communication system coupled to the downhole tool, the communication system adapted to communicate to a surface device; and

wherein the communication system is adapted to send the first datum to the surface device in uncompressed form, and wherein the communication system is further adapted to send the second datum to the surface device in a compressed form.

14. The drill string as defined in claim 13 wherein the communication system sends the second datum in compressed form as a difference between the first and second datum.

15. The drill string as defined in claim 14 wherein the communication system encodes a most likely value of the first delta value as a zero.

16. The drill string as defined in claim 15 wherein the communication system encodes a second most likely first delta value as one of a value of one and a value of two.

17. The drill string as defined in claim 14 wherein the communication system smoothes data of the first parameter prior to sending the data.

18. The drill string as defined in claim 17 wherein the communication system smoothes the data by application of substantially the following equation:

$$y_i = \frac{x_i + (\alpha * y_{i-1})}{1 + \alpha}$$

where y is a smoothed datum having index i , x is a raw datum, and α is a smoothing coefficient.

19. A method comprising:

sending a first list from a downhole device within a drill string to a surface unit, the first list comprising a first value, in uncompressed form, of a downhole parameter; and

sending a second list through the downhole device within a drill string to the surface unit, the second list comprising a second value, in compressed form, of the downhole parameter.

20. The method as defined in claim 19 wherein sending a second list further comprises sending a plurality of lists, each list comprising a value of the downhole parameter in compressed form, and with each value related to the first value.

21. The method as defined in claim 20 wherein a number of lists sent comprising values of the downhole parameter in compressed form is selected, at least in part, on a bit error rate of data communications from the downhole device to the surface unit.

22. The method as defined in claim 19 wherein sending a second list further comprises sending a second list comprising a plurality of values in compressed form.

23. The method as defined in claim 22 further comprising encoding the plurality of values one each in each data interval of the list.

24. The method as defined in claim 23 further comprising encoding four bits of data within each data interval.

25. The method as defined in claim 22 further comprising encoding two of the plurality of values within a data interval.

26. The method as defined in claim 25 further comprising encoding four bits of data within each data interval, each of the two values within the data interval spanning two bits.

27. The method as defined in claim 19 wherein sending the second value in compressed form further comprises:

sending in the second list a difference value being a difference between the first and second values; and

reconstructing the second value from the first value and the difference value.

28. The method as defined in claim 27 further comprising:

sending a third list having a third value by sending a difference value being a difference between the second value and the third value; and

reconstructing the third value from the first value, the difference value associated with the second value and the difference value associated with the third value.

29. The method as defined in claim 27 further comprising:

sending a third list having a third value by sending a difference value being a difference between the first value and the third value; and

reconstructing the third value from the first value and the difference value associated with the third value.

30. The method as defined in claim 27 wherein sending the difference value further comprises encoding a most likely difference value as a zero.

31. The method as defined in claim 30 further comprising encoding a second most likely difference value as one of a value of one and a value of two.

32. The method as defined in claim 19 further comprising actively changing a number of bits in the list comprising the second value based on an error rate in data transmission.

33. A method comprising:

sending an uncompressed list from a downhole unit within a drill string to a surface computer, the uncompressed list comprising a first datum in uncompressed form and a second datum in uncompressed form; and

sending a compressed list from the downhole unit within the drill string to the surface computer, the compressed list comprising third datum related to the first datum and a fourth datum related to the second datum, and wherein at least one of the third and fourth datum is in a compressed format.

34. The method as defined in claim 33 wherein sending the compressed list further comprises sending both the third and fourth datums in compressed format.

35. The method as defined in claim 34 wherein sending both the third and fourth datums in compressed format further comprises:

sending a difference value being a difference between the first and third datums; and

sending a difference value being a difference between the second and fourth datums;

36. The method as defined in claim 35 further comprising:

determining the third datum by a surface computer, the determination based on the first datum and the difference value being the difference between the first and third datums; and

determining the fourth datum by the surface computer, the determination based on the second datum and the difference value being the difference between the second and fourth datums.

37. The method as defined in claim 33 wherein the uncompressed list precedes the compressed list.

38. The method as defined in claim 33 wherein the compressed list precedes the uncompressed list.

39. A method comprising sending a first list from a downhole device within a drill string to a surface computer, the first list containing a plurality of values of a downhole parameter, at least one of the plurality of values in compressed form.

40. The method as defined in claim 39 wherein sending the first list further comprises sending an uncompressed value of the downhole parameter, and at least one compressed value of the downhole parameter.

41. The method as defined in claim 40 further comprising calculating the compressed value of the downhole parameter as the difference between the uncompressed value and a value of a datum to be compressed.

42. The method as defined in claim 39 further comprising:
sending a plurality of additional lists, each list containing a plurality of additional values of the downhole parameter; and
wherein the plurality of values in the additional lists are interleaved.

43. The method as defined in claim 39 further comprising:
sending a plurality of additional lists, each list containing a plurality of additional values of the downhole parameter; and
wherein the plurality of values in the additional list are overlapped.

44. The method as defined in claim 39 further comprising sending a second list having a plurality of compressed values of the downhole parameter, and wherein the compressed values are related to the uncompressed value of the first list.

45. The method as defined in claim 44 further comprising calculating each of the compressed values as a difference between the uncompressed value of the first list and the datum to be compressed.

46. The method as defined in claim 39 further comprising smoothing the plurality of downhole parameters prior to compression.

47. The method as defined in claim 46 wherein smoothing further comprises smoothing according to substantially the following equation:

$$y_i = \frac{x_i + (\alpha * y_{i-1})}{1 + \alpha}$$

where y_i is a smoothed datum having index i , x_i is a raw datum of index i , y_{i-1} is a smoothed datum of index $i-1$, and α is a smoothing coefficient.

48. A method comprising:

sending a list from a downhole device in a drill string to a surface, the list comprising a plurality of samples of a parameter in compressed form; and

calculating a time tag for each of the plurality of samples in the list by:

calculating a time tag for a most recent sample of the plurality of samples; and

calculating a time tag for remaining samples based on the time tag for the most recent sample and a period at which samples are taken.

49. The method as defined in claim 48 wherein calculating a time tag for a most recent sample further comprises calculating a time tag for a last sample in the list.

50. A method comprising:

sending a first list comprising a time tag for a datum of a plurality of datums of historical data; and

sending a second list comprising a plurality of datums from sequential samples, and a counter value indicative of a relationship of the plurality of samples in the second list to the datum having the time tag of the first list.

51. The method as defined in claim 50 further comprising determining a time tag for each of the plurality of datums in the second list based on the time tag of the first list, the count value, and a time period between sampling that creates each datum.

52. The method as defined in claim 50 wherein sending the first list precede sending the second list.

53. A method comprising:

sending an uncompressed value of a first parameter in a first list;

sending an uncompressed value of a first parameter in a second list; and
sending a plurality of compressed values in a third list; AND
calculating the uncompressed values of the compressed values in the third list using one of the uncompressed value in the first list and the uncompressed value in the second list.

54. The method as defined in claim 53 further comprising sending the third list between the first and second lists.

55. The method as defined in claim 53 wherein the sending a plurality of compressed values step further comprises sending a plurality of compressed values where one of the values, in uncompressed form, is the same value as the uncompressed value of the second list.

56. The method as defined in claim 54 wherein the sending of the plurality of compressed values further comprises sending a plurality of compressed values where one of the values, in uncompressed form, is determined from one of the values in the first list.